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WINCHES AND LABORATORIES

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The Deep-Sea Winch

The deep-sea winch of the *Albatross* would ave to serve at deep-sea coring with heavy ears and at deep-sea trawling. Deep-sea oring in particular could be foreseen to expose ne winch to a very high strain in view of the ery considerable weight of the corer and the able, amounting to as much as 8,500 kg at he deepest soundings. Waves and swell could e expected to add to the strain and, further, he lowering of the cable had to be stopped ery abruptly when the corer had been released t the sea floor. This demanded a specially esigned motor, apart from requiring great nechanical strength in all parts of the winch. n view of the great depths, high speed was ecessary in order to save time. Finally, the ension in the cable could be expected to reach very high value when the corer was being ulled out of the bottom. As compared with leep-sea coring, trawling would make quite noderate demands upon the winch, as far as peed and strength were concerned.

In the conventional trawl winch for deep-sea vork the hauling power is exercised by the arrel, which does not appear to be quite atisfactory when the tension in the cable is ery high. The high tension would expose he barrel, and especially the flanges, to an excessive strain. Furthermore, the cable itself would be subject to very heavy wear and tear being stored under such a high tension and with the layers on the barrel cutting in to each others, when the cable is being hauled in under that very high tension. Even with a good cable guide it will frequently occur that the cable is not stored quite uniformly on the barrel, which will give rise to sudden jerks at the subsequent lowering of the corer, endangering cable and corer alike. It was, therefore, decided to build a winch according to the principles laid down for the deep-sea anchoring equipment of the *Meteor* (Spiess, 1932), a duplicate of which was built on the *Willebrord Snellius* (Perks, 1938).

In the deep-sea anchoring equipment referred to the cable was paid out, and hauled in, by means of the anchor capstan, and it was wound on the cable barrel at a low tension. However, if only one capstan is used the cable will move continually towards one end of it and the cable will slip back to the centre of the capstan with more or less heavy jerks. This would be most inconvenient at deep-sea corings since it would expose the cable to incessant twists and, further, the corer might become accidentally released during an early stage of the lowering, when such a release

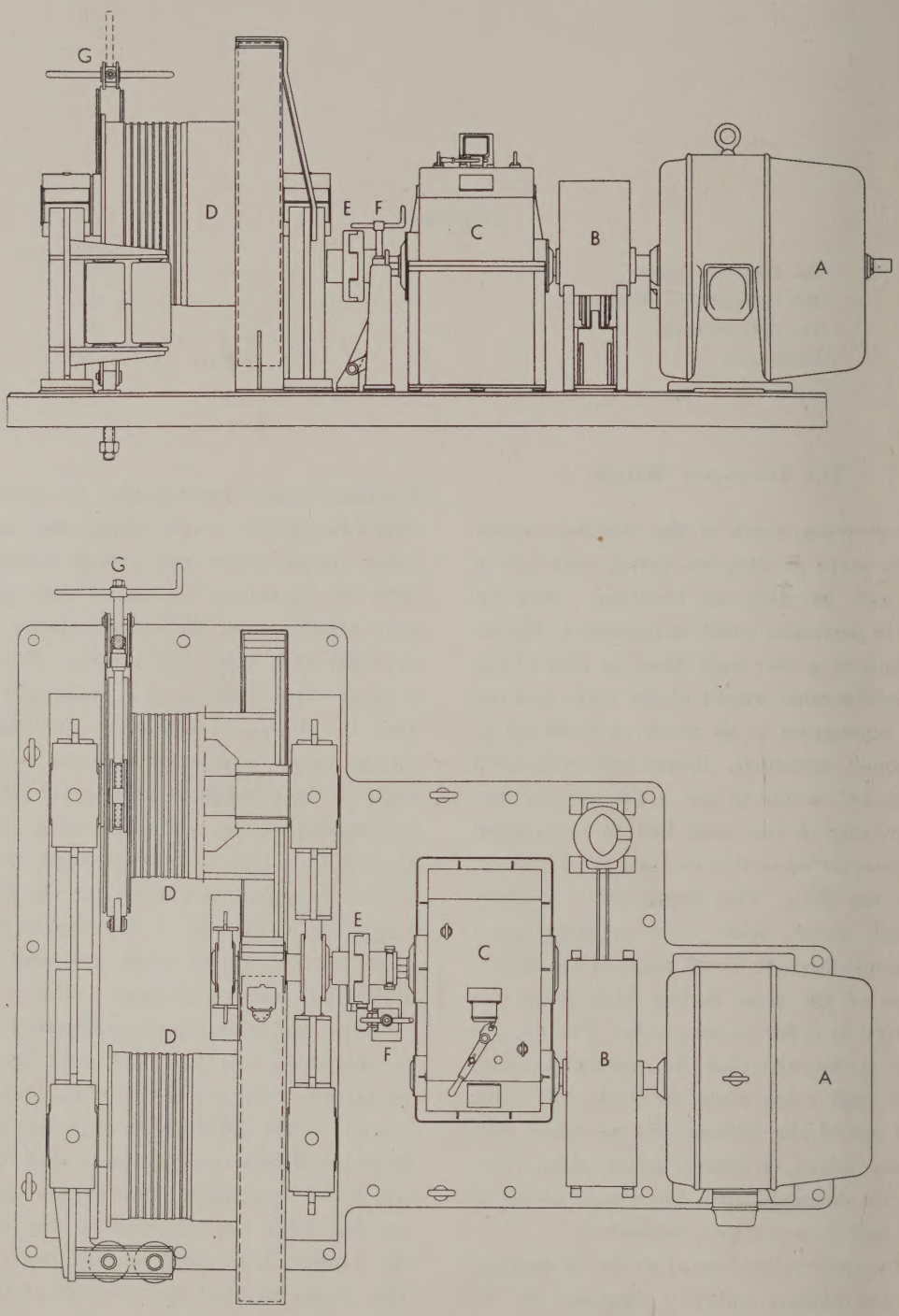

Fig. 1. The deep-sea winch, seen from the front and from above. A = Electric motor, B = Friction coupling, C = Ge box, D = Drums, E = Clawcoupling, F = Change-over gear, G = Screw brake.

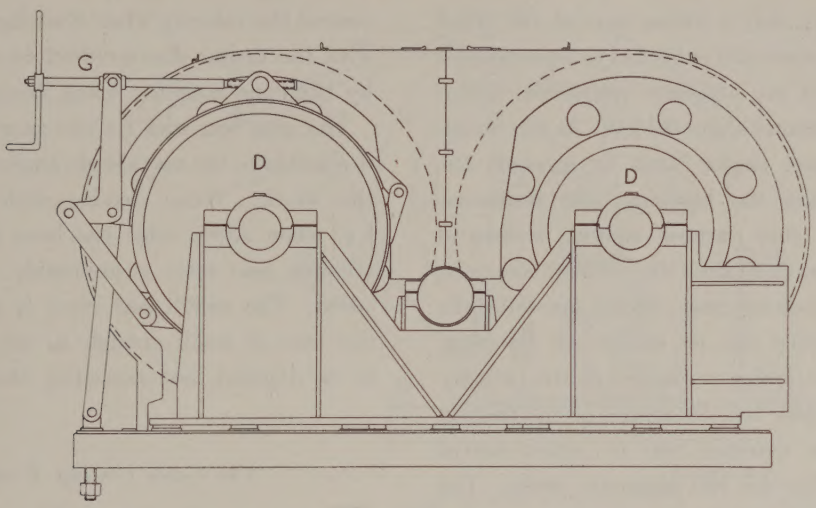

Fig. 2. The deep-sea winch, right-hand view. (Legend cp Fig. 1).

ould be fatal to the corer. It would also be npossible to run the capstan at a high velocity. s pointed out by Mr. AXEL JONASSON, nstrument maker to the Oceanographic Insti- ute in Göteborg, the inconvenience can be voided by using two drums coupled together nstead of one capstan, because then the cable ill remain stationary on both, particularly the drums were fitted with a number of rooves for the cable to run in.

The deep-sea winch consists of *the main inch* with the two drums, and *the cable coiling inch* with the barrel.

The Main Winch

The main winch (Fig. 1—2) consists of: he electric motor (A), a friction coupling vith a magnetic brake (B), a gear box totally nclosed (C), the two drums (D) with two louble bearing brackets, the main gear driving he drums, and bearing brackets for the gear, a clawcoupling (E) between the secondary haft and the main gear, with change-over gear F), and a screw brake (G) for one of the drums. All parts are assembled on a common bed late of welded construction (Fig. 1).

The electric motor driving this winch has an output of 110 kW at 700 r. p. m. and it is fed from a direct-current dynamo (Plate I) of 230 V and an output of 130 kW at 550 r. p. m. The Dynamo is driven by a Diesel engine, Atlas Diesel K 54 E, a two-stroke engine with four cylinders with an output of 200 h. p. at 550 r. p. m. It is connected to the motor by a Ward-Leonard coupling.

The field winding of the motor is connected to a constant line voltage, so the direction and speed of the motor is determined by the sign and magnitude of the voltage furnished by the dynamo. The sign of the voltage may be changed by means of a reverser, and its magnitude is adjusted by means of a resistance connected to the field winding of the dynamo. When the dynamo is fully exited and, consequently, the tension has reached its maximum value, the speed of the motor may be further increased by diminishing the current in its field winding by cutting in a resistance.

During the lowering of the corer the motor will act as a brake by functioning as a dynamo when so much cable has been paid out that the tension in the cable is sufficiently high to drive the winch against the friction. The dynamo will then run as a motor and drive the Diesel engine. In view of the losses in

the machinery only a minor part of the effect furnished by corer and cable has to be consumed by cutting in an adequate resistance, which is able to consume about 30 kW. As the winch and the Diesel engine tend to increase the velocity during the lowering, the resistance designed for this purpose should be cut in successively so as to keep the velocity constant. There is a locking gear which prevents the resistance being cut in except at lowering.

The electric motor is coupled to the primary shaft of the gear box by means of the friction coupling, the external rim of which serves as a brake disc for the magnetic brake. The brake will operate as soon as the field winding of the motor is currentless.

The primary shaft is fitted with a double pinion which can be moved in axial direction so as to drive one of the two pinions on the secondary shaft of the gear case. The gear ratios stand as 2: 1, being respectively 5.8 and 2.9.

The secondary shaft is coupled to the main gear driving the drums by a claw coupling that can be disconnected. The main gear consists of a pinion on the shaft coupled to the secondary shaft of the motor gear, driving the toothed wheel rims of the two drums. The gear ratio in this transmission is 7.8, so the total gear ratio between motor and drums is 45.2 or 22.6, depending on the adjustment of the gear case.

The grooved drums are mounted on shafts cradled in two double brackets. In order to spare the cable, the diameters of the drums are as large as 800 mm. There are eight grooves for the cable in each drum though, as a rule, it was not found necessary to use more than five of them.

The screw brake applied to one of the grooved drums may be used to diminish the torque exerted on the motor during the lowering when much cable has been paid out, or to secure the drums when the gear is being adjusted. The screw brake is used, further, to control the velocity when lowering is performe with the drums disconnected from the moto by the claw coupling being disconnected.

The gear box with its two gear ratios mak it possible to use two speed ranges when drivi the winch. When driving with a big loa i. e. when much cable has been paid out, t greatest gear ratio is preferable, giving a l speed. The small gear ratio is applied wh the load is small enough to allow the spe to be doubled, not exceeding about 3,000 l

The Cable Coiling Winch

The cable coiling winch (Fig. 3) consists The electric motor (H), a friction couplin with a magnetic brake (J), a gear case (K) cable coiling barrel (L), and a cable gu (M). All parts are assembled on a welc steel bed plate.

The motor is a 9 kW direct current mo coupled to the barrel in a similar way that described above for the main wi and its motor. As in the case of the m winch the gear can be adjusted for two spe with the ratio 2: 1. As the barrel must out the cable at the same speed as the ca is paid out by the main winch, or vice ve the couplings are interlocked electrically s to make it impossible to start the mo unless both gears are adjusted in the s way. The cable guide can be adjusted for cable diameters, viz. by steps of 2 mm fro to 22 mm. The barrel is 800 mm in diam and 2,200 mm between the flanges, and diameter of the flanges is 1,600 mm. It store 12,000 m cable tapered from 12 t mm in diameter. The barrel is fitted wi screw brake (N).

The Disposition of the Winch

The winch was stationed in Hold N and the Diesel engine, together with the d current dynamo, in Hold No. 3. The

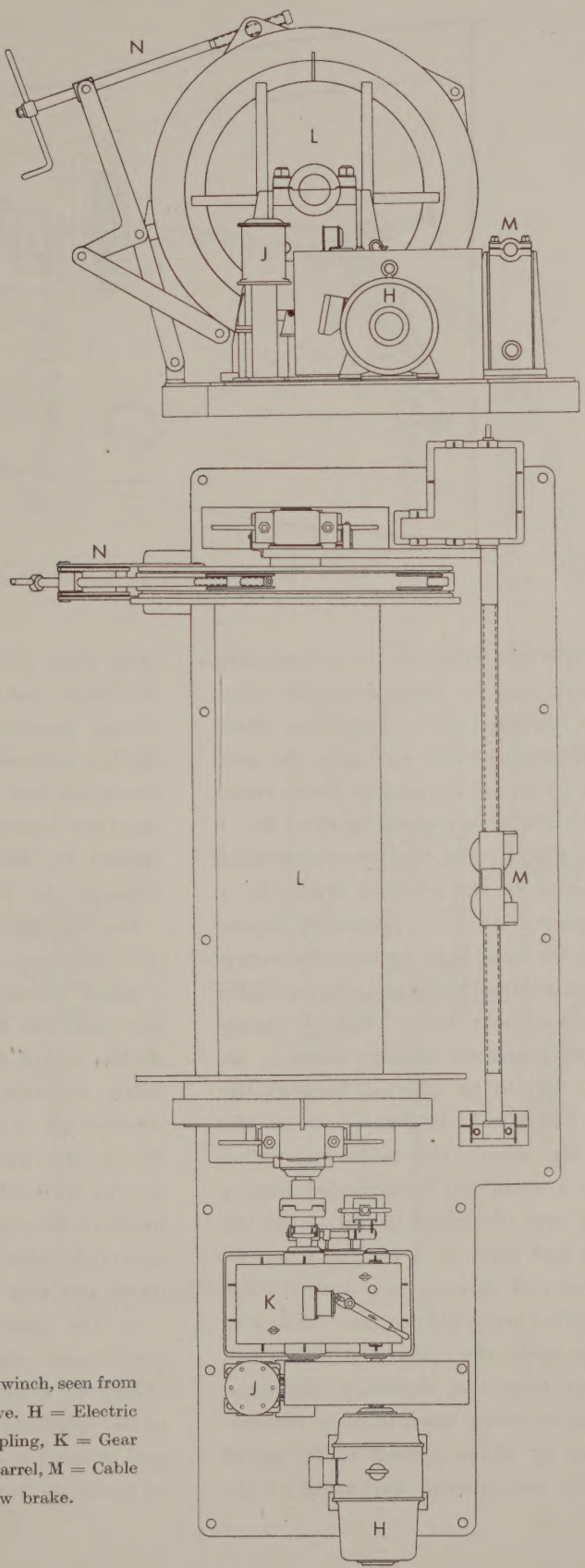

Fig. 3. The cable coiling winch, seen from the right and from above. H = Electric motor, J = Friction coupling, K = Gear case, L = Cable coiling barrel, M = Cable guide, N = Screw brake.

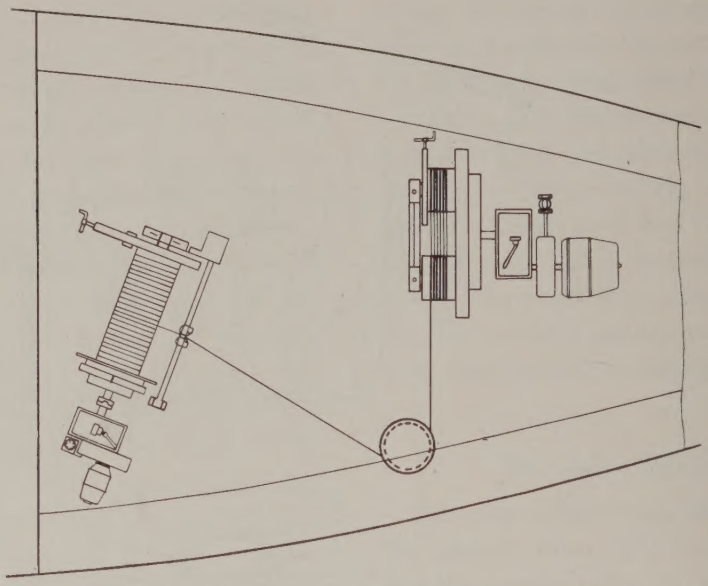

Fig. 4. The deep-sea winch in Hold No. 1.

was altogether too bulky to be conveniently placed on deck, and by being stationed below deck it was, further, protected from sea water and rain. When the hatch was open, the hold was covered by an awning against heavy rains.

The disposition of the winch in Hold No. 1 is shown by Fig. 4. The cable was conducted from the barrel to the grooved drums by a horizontal sheeve. As it was practically impossible to keep the cable tight between the drums and the barrel under all circumstances, especially when the speed was being reduced during lowering, or increased during hauling, an accumulator had to be inserted between the sheave and the barrel. Halfway between the barrel and the sheave the cable was pulled upwards by a small block suspended from a wire passing over two other blocks at the top of the hold, and carrying a load of about 50 kg at its other end, running in a vertical tube. The accumulator being able to take home 4 m length of the cable, the operator of the winch had time to take the necessary measures, should the accumulator block indicate impending slackness by allowing itself to be pulled upwards. The accumulator indicating at the same time the tension in the cable betwee the drums and the barrel in a qualitative wa it was possible to prevent the tension fro getting unnecessarily high. The operator the winch had to keep the accumulator und constant observation, as the cable would spoiled by kinking if allowed to get sla between the two winches.

On the main deck, beside Hold No. 1, davit was erected at the starboard rail, carryi a pulley with a diameter of 800 mm, by whi the cable was conducted into the sea (Fig. At the top of the hold, at the port side of t hatch, a similar pulley was set up serving conduct the cable from the winch to the dav The pulleys were made of steel casting in or not to be much worn by the cable which w made of very hard steel. A dynamometer w mounted halfway between the pulley in t davit and that in the hatch.

As the cable was a tapered rope, cert precautions were necessary when haulin When the grooved drums were passed by c of the junctions where the diameter of the ca was reduced to a lower value, the thicker p of the cable was running in at a certain spe

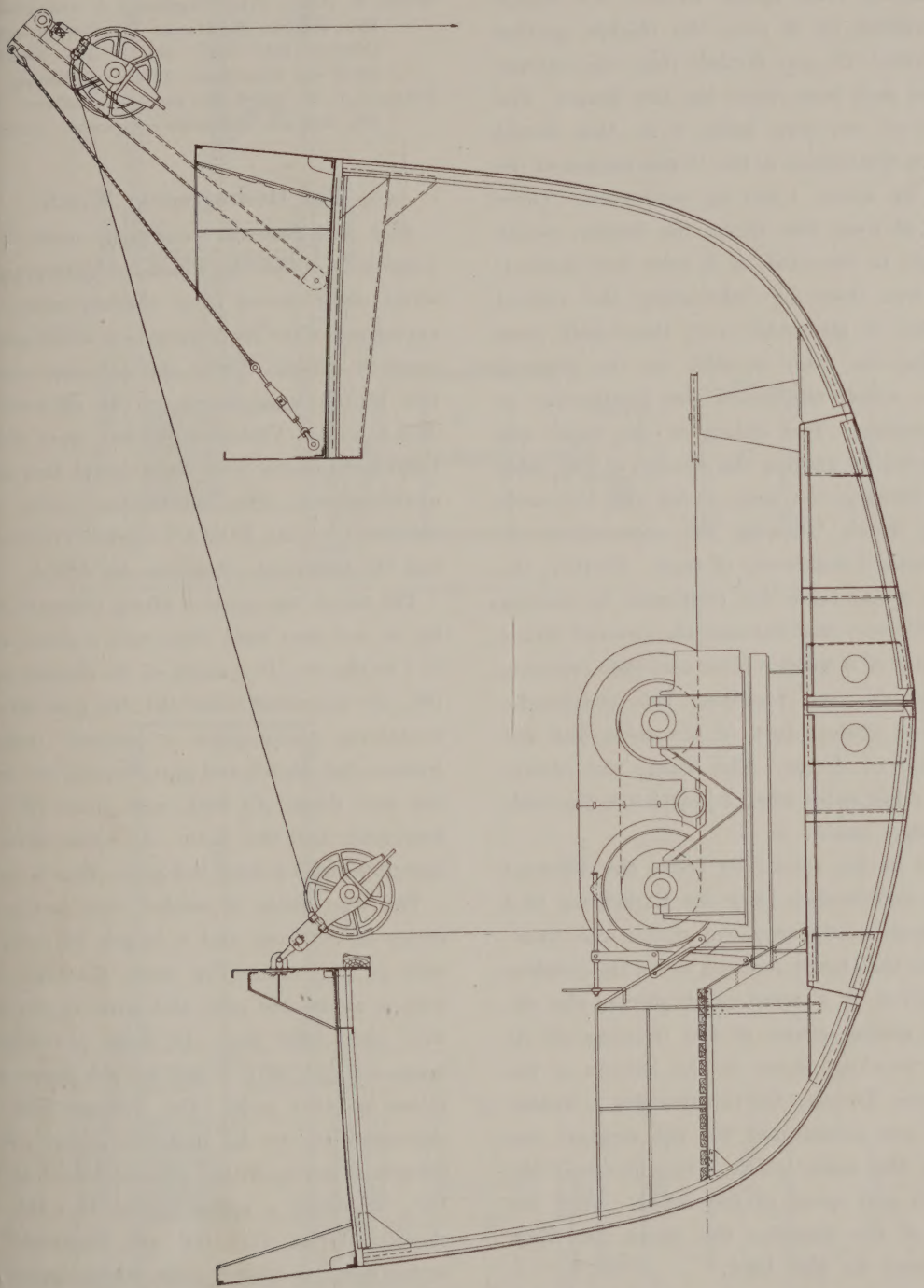

Fig. 5. Schematic view of the winch in Hold No. 1, and the davit on the main deck, and the track of the cable.

and the thinner portion of the cable followed at a slightly lower speed. In fact, in a change of diameter by 4 mm, the thicker portion will travel 12 mm farther than the thinner portion each turn round the two drums. The length of one turn being 6 m, this should increase the tension in the 12 mm section of the cable by about 1,500 kg each turn. There being at least five turns, the tension would be fatal to the cable if it were not checked. This was done by lubricating the critical portions of the cable very thoroughly, thus enabling the cable to slide on the grooved drums, which eliminated the lengthening of the junction. The sliding of the cable was facilitated by making the tension in the cable small between the main winch and the cable coiling winch, allowing the accumulator to take home a maximum of slack. Further, the sliding of the cable was facilitated by making the cable very taut between the grooved drums by means of a wooden lever and then releasing it suddenly, and repeating this continually until the critical part of the cable had left the grooved drums. The winch was always run at a low speed when a junction in the cable was being hauled in.

After having served on board the *Albatross* during the Swedish Deep-Sea Expedition in a most satisfactory way the winch was transferred to the Danish research vessel the *Galathea* and served as a trawl-winch during the circumnavigating cruise of the *Galathea* on its record trawlings down to the bottom of the Philippine Trench. On the *Galathea* a weaker motor was substituted for the original one driving the main winch, which lowered the strength and speed of the winch. After the cruise of the *Galathea* the winch has been transferred to the USA.

The winch was designed by ASEA, Västerås, Sweden, and this firm also supplied the electrical equipment. The mechanical parts were built in the NOHAB works at Trollhättan according to ASEA's specification.

References

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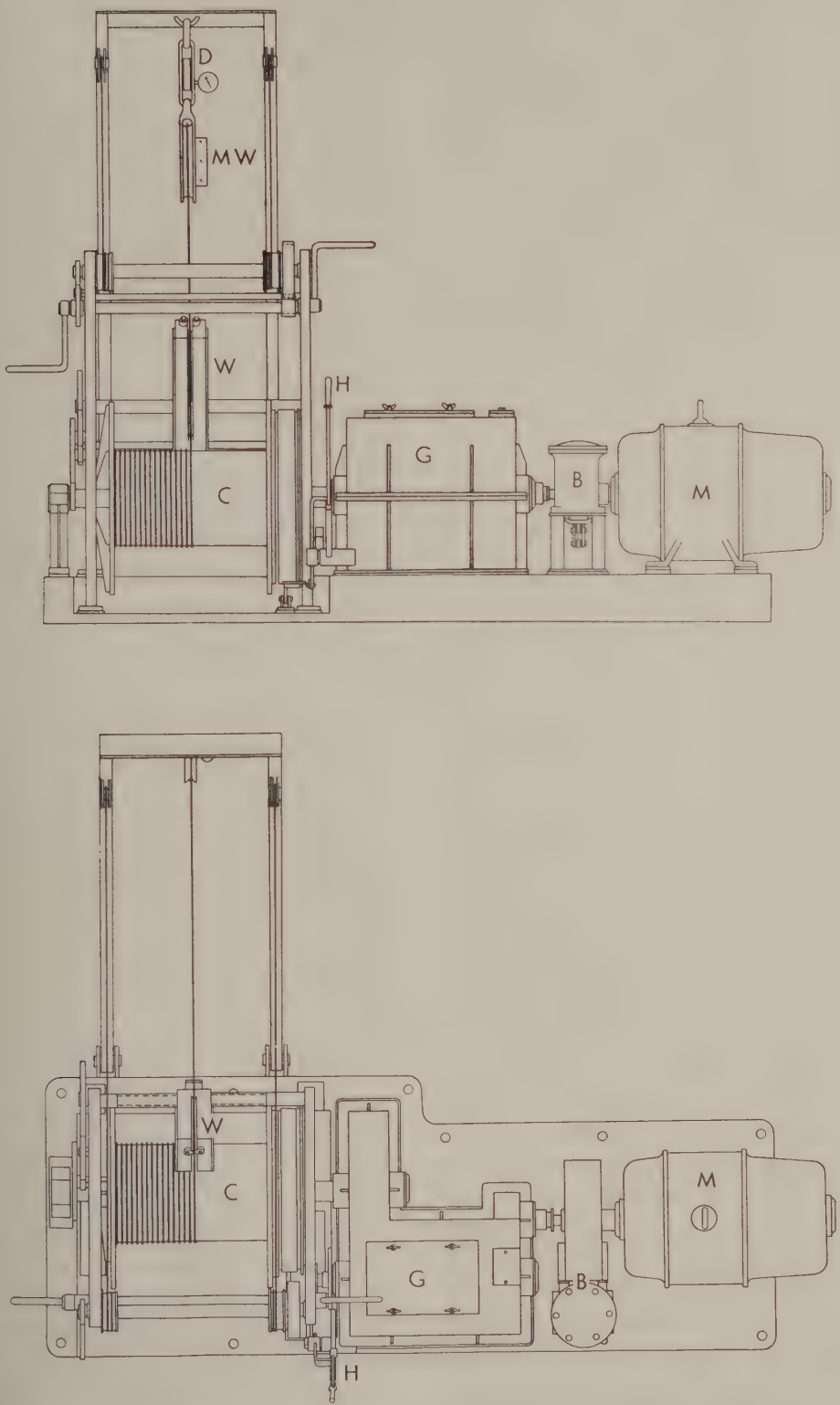
The Hydrographic Winch

War and post-war conditions made it im possible to obtain the winch for hydrographic serial observations from manufacturers wit experience of the requirements of oceanographi research vessels. Using the excellent descrip tion of the serial winch of the »Meteor» th ASEA works, Västerås, Sweden, were able t build a duplicate with only one or two mino modifications. The mechanical parts wer delivered by the NOHAB works, Trollhättan and the electrical accessories by ASEA.

The winch was given a lifting power of 1,00 kg on a 4 mm steel wire, and a mean spee of 1 m per sec. It consists of the electric mot (M), the magnetic brake (B), the gear box (G containing motor-gears, a specially designe friction disk clutch and gears driving the drun the wire drum (C) with wire guide (W) an footbrake, and the davit. All these parts a assembled on a welded bed-plate (Figs. 6 and 7

The wire drum of welded steel has a di meter of 300 mm and a length between t rims of 600 mm. The mean diameter wi wire is about 440 mm, and with 11,000 m wire about 580 mm. In order to obtain mean velocity of 1 m per sec the drum mu rotate at 44 r. p. m. The average load w estimated at 700 kg and the average effe consumed during lifting was calculated at 11 HP. Therefore a motor giving 13.5 HP w chosen. When 11.7 HP are consumed t motor speed is 1020 r. p. m. which determin the overall ratio of the gears to about 23. Th is divided between the motor gear and t drum gear with gear ratios of 4.7 resp. 5 In view of its higher velocity the motor ge is running in oil.



. 6. The hydrographic winch. B = Magnetic brake, C = Wire drum, D = Dynamometer, G = Gear box, H = Hand lever, M = Electric motor, MW = Meter wheel, W = Wire guide.

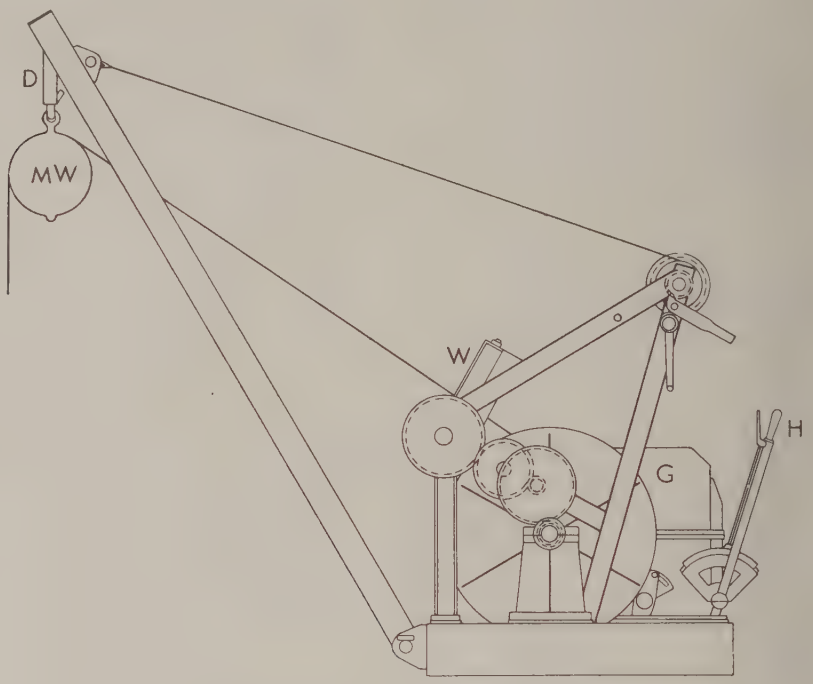


Fig. 7. The hydrographic winch, seen from the left. (Legend cp Fig. 6).

When tested during the cruise the winch was found to have a slightly higher mean velocity than requested, viz. about 120 m/min at lowering, and 80 m/min at heaving.

The magnetic brake (B) operates as soon as the field windings of the motor are currentless. The time lag is about 0.5 second. The external rim of the fixed clutches between motor and gears acts as a brake disk.

The electric controller is fitted with six steps to control the speed for both heaving and lowering. Only the three highest speeds can be used for an indefinite time; the others are only for intermittent use because of the risk of overheating the resistance. Speed 1 is extremely slow and proved useful for exact operation during lifting. The electric power is obtained from the ship's mains.

An essential part of the winch is the friction disk clutch which serves two purposes. It can be operated as a friction disk brake, destroying the energy delivered by the rotating drum during lowering. Further, it serves as a safety coupling which operates as soon as the pu on the wire reaches 950 kg which is abou per cent of the breaking strength of the v

The friction disk clutch was used du lowering, when a higher velocity than the m could give was desired, especially, when speed was reduced at great depth, on acc of the drum diameter being diminished b amount corresponding to the length of paid out. The maximum speed at lowering never allowed to exceed about 2.5 m per as otherwise the danger of getting kinks very great. During shallow series the v bottles were generally lowered by the m The friction between the disks can be adju as the force of the springs pushing the together is controlled by a hand lever The transmission ratio is chosen so that maximum handpower is 6 kg. The clut sensitive to a change in the tension in the of 15 kg. The angle in which the hand can be moved is 30°, which allowed a adjustment of the speed at which the

lowered. In addition the speed can be olled by the foot brake on the wire .

e maximum weight which can be operated ie winch before the safety clutch acts is table by springs on the friction disks, io change from the allowed 950 kg was sary during the cruise. In this connection advantage in the construction may be ioned. The drum gear is not separated the friction disks by a splash shield enting drops of grease to get between the . It happened very often that the heat loped by the disks melted the grease, h got between the disks diminishing the on. In order to facilitate the cooling ie disks, the cover of the gear box was ys kept open while the winch was running. wire guide spreads the wire as evenly as ible on the drum. Difficulties arose only the rims of the drum where sometimes much wire was accumulated at heaving.

ie davit is fixed on two steel wires and the nsion can be adjusted by means of two ll hand-drawn wire drums. The maximum ance from the winch to the wire is 1.3 m, which position the wire is about 1 m from ship.

he meter wheel (MW) is attached to the it without the use of accumulators. The ion of the wire was at first determined by ynamometer similar to that used on the teor». Later the same type of dynamometer as used for the determination of the ten- during the coring operations was attached veen the davit and the meterwheel. Only ugh calibration was made for the occasions n the wire was vertical. An oil pressure of g per cm² corresponded to 11.5 kg tension he wire. When the wire deviates from the ical the indicated pressure decreases cor- onding to the deviation. The dynamometer sed to indicate when a load attached to wire hits the bottom. This is necessary ing coring operations, and when water samples are being collected very close to the bottom.

The wire was a galvanized 4×3 strand steel wire 4 mm in diameter delivered by Wright Ropes Ltd. The breaking strength of the steel was extremely high, 220 kg per mm². The weight of the wire was 56 kg per thousand meters. The wire proved to be excellent as it showed only little inclination to kink, but on the other hand it severely weared the rolls of the wire guide. It is recommended that the rolls should be cradled in ball bearings and their diameter increased.

The Optical Winch

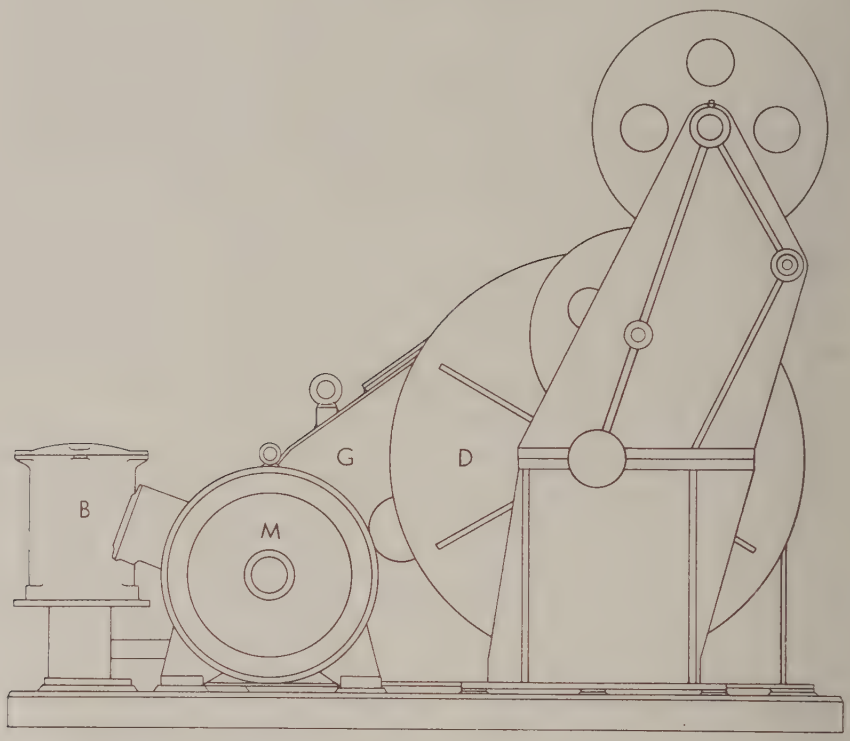
This winch was constructed by ASEA to meet the special demands of the technics used for the measurement of light. It was sized for 600 m rubber cable of a diameter of 16.5 mm and for a pull of 150 kg on the cable from the top of the coil.

Motor (M), gear wheel case (G), bearing bracket and shoe brake (B) are mounted on a bottom plate (Fig. 8). The motor which is capable of developing 2.25 HP. is directly coupled to a 3.7-fold motor gear which is connected to a 5-fold cable drum gear. A gear rim is attached to the other end of the drum shaft. It drives over an intermediate gear a screw spindle which carries the travelling cable guide (CG). The cable runs through two vertical rollers, a horizontal roller preventing it from running off.

The magnetic shoe brake acts on the motor coupling with a momentum of about 10 kgm and comes into action when the motor field is dead.

The control is placed under deck and operated by means of a wheel near the winch. It works for 4 different velocities in each direction, the highest being 1 m/sec.

The winch is placed at the after poop deck on the port side so that the cable may be conveniently drawn out along the 7 m crane



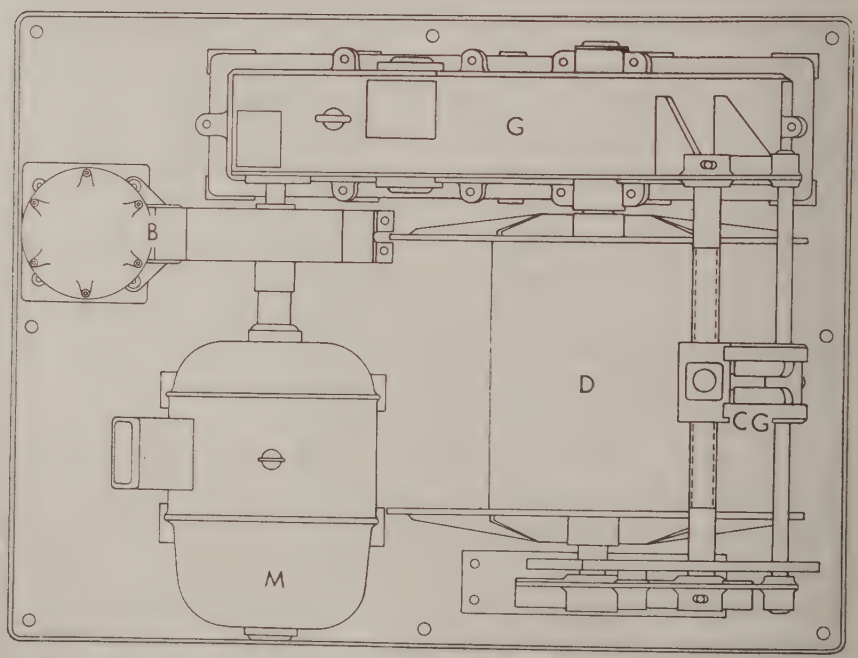
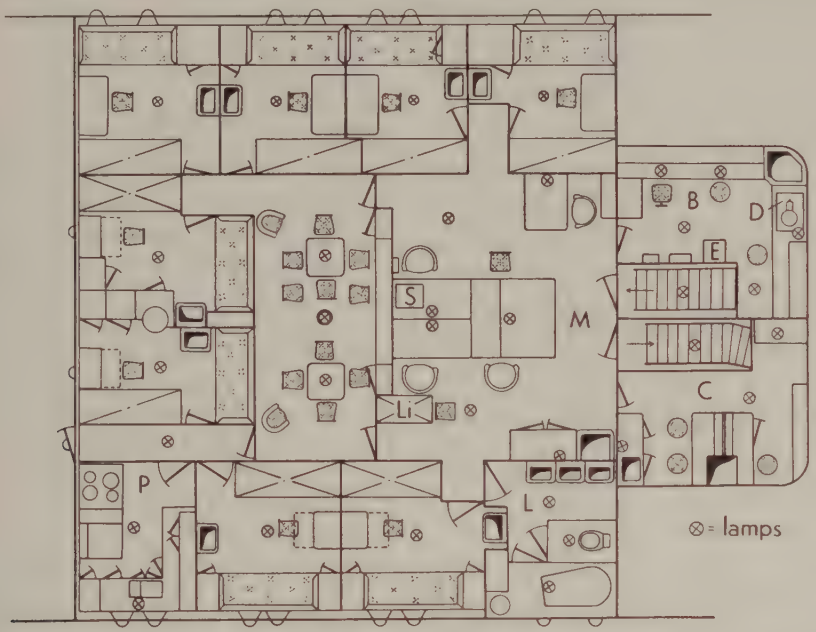


Fig. 8. The optical winch. B = Shoe brake, CG = Cable guide, D = Wire drum, G = Gear box, M = Electric



g 9. Accomodations on the main deck. B = Biological laboratory, C = Chemical laboratory, M = Main laboratory, L = Lavoratory, P = Pentry, Li = Lift, S = Swingtable, D = Distillation device, E = Echosounder.

ecting from the stern of the ship; and ing to move out the instruments from the low of the ship.

he cable is an eight-conductor manufactured yLiljeholmens Kabelfabrik. The cable on the ich drum is united to the cable leading to laboratory by means of water-tight connex- with silver contacts mounted on the port e of the drum. These connexions are broken n the winch is operated.

he photometer winch proved to be very ful during the expedition though the motor ver was somewhat inadequate.

Laboratories

he »Albatross» being a cargo ship it was designed for the work in prospect and its uipment as a research vessel took a provi- nal character. The entire hold No. 2 amid- ps was at disposal for the internal accomoda- ns for scientific work. This enclosed space st be carefully utilized to take the necessary laboratories, the cabins, and the stores in two floors.

Above the hatch on the poop deck no build- ing was allowed as this might obscure the view from the bridge. Only an entrance lobby (Plate II) was constructed, on the port side. In the lobby a glass container with water was mounted which was used for the reversing thermometers when attaining temperature equi- librium.

A stair lead down to the laboratory (Fig. 9) on the main deck. The port side of a great central table was occupied by optical instru- ments, the sensitive galvanometers being placed on a swing table. A telephone connected to a loudspeaker at the photometer winch performed the necessary communication between the winchoperator and the observer at the table. The main laboratory chiefly served as a room for writing and calculation. A barograph and the recording mechanism of an anemograph were also placed here.

Two small laboratories opened to the main

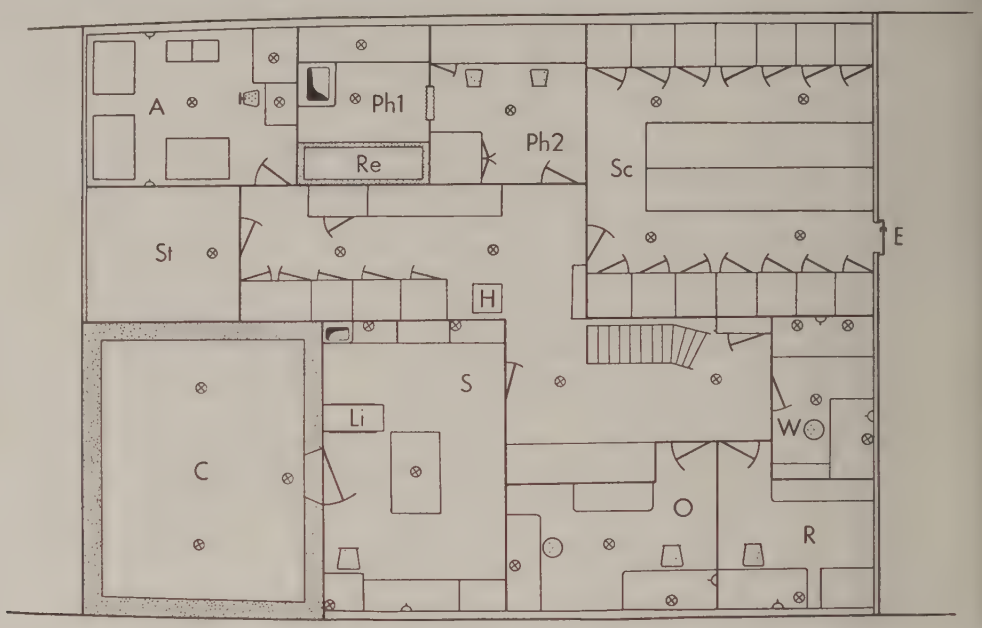


Fig. 10. Accomodations between the main deck and the orlop. W = Workshop, R = Compartment for elec instruments, O = Optical room, S = Sediment laboratory, C = Cold store for sediment cores, St = Store for provi A = Aquarium room, Ph1 = Dark room, Ph2 = Photographic laboratory, Sc = Store for instruments, Li = Lift, Re frigerator, H = Hatch to the orlop, E = Emergency exit.

laboratory. The chemical laboratory, on the starboard side, was provided with specially constructed titration tables with indirect illumination. In the biological laboratory, on the port side, a considerable part of the wall space was occupied by the echo-sounding apparatus. There was also a distillation device with electric heating placed on a swing table.

The mess (Fig. 9) was situated astern of the main laboratory. Owing to the cross bars it had to be rather narrow. Shelves with essential handbooks, manuals, tables etc. run along the inboard fore bulkhead. The mess as well as the laboratories mentioned were fitted with skylights.

The main laboratory and the mess were partly surrounded by the cabins, 4 cabins accomodating one man each, on the port side, and 4 cabins accomodating two men. A lavoratory and a pentry were situated on the starboard side. All these compartments were fitted with portholes.

Between the main deck and the orlop an extra floor was built in hold No 2 for la tories, store-rooms, and a small work (Fig. 10).

The work-shop was partitioned agains fore bulkhead. It contained a bench and a high-speed sensitive drill together the usual equipment. On the starboard was a compartment for the radio equip and for recording instruments for the acou explorations. An optical room was spe designed for measurements with the Ty meter and with the Pulfrich photome

Another laboratory on the starboard was fitted with suitable arrangements fo treatment of the sediment cores. In vi the great number of cores that were col this was an important routine procedure aluminium tubes containing the cores stored in a cold room close by, where were kept at a temperature of about

Sternmost on the port side there biological laboratory with aquariums fo and warm water.

e main store for provisions was situated
en the cold room and the biological
atory.

e photographic laboratory, on the port
was divided into two parts. The develop-
s were performed in the inner compart-
which also contained a refrigator where
photographic material and the solutions
kept at a temperature of 18° C. The
room was used for photographic pur-
, for making enlargements etc.

nally, a large store was situated afore on
port side. Here were also closets for the personal equipments of the staff. A steel watertight emergency door gave access to hold No. 1. The store room was not included in the airconditioning system previously described as was the case with the laboratories and the work-shop on this floor.

As it was considered inconvenient to transport all material on the rather steep stairs a small lift $1 \times 0.5 \times 0.6$ m was constructed which, worked by hand, maintained communication between the poop deck and the two floors in the scientific accomodations.

THE TRACK OF MS AL

AB KARTOGRAFISKA IN
ESSELTE AB STOCKHO

BATROSS 1947 - 1948

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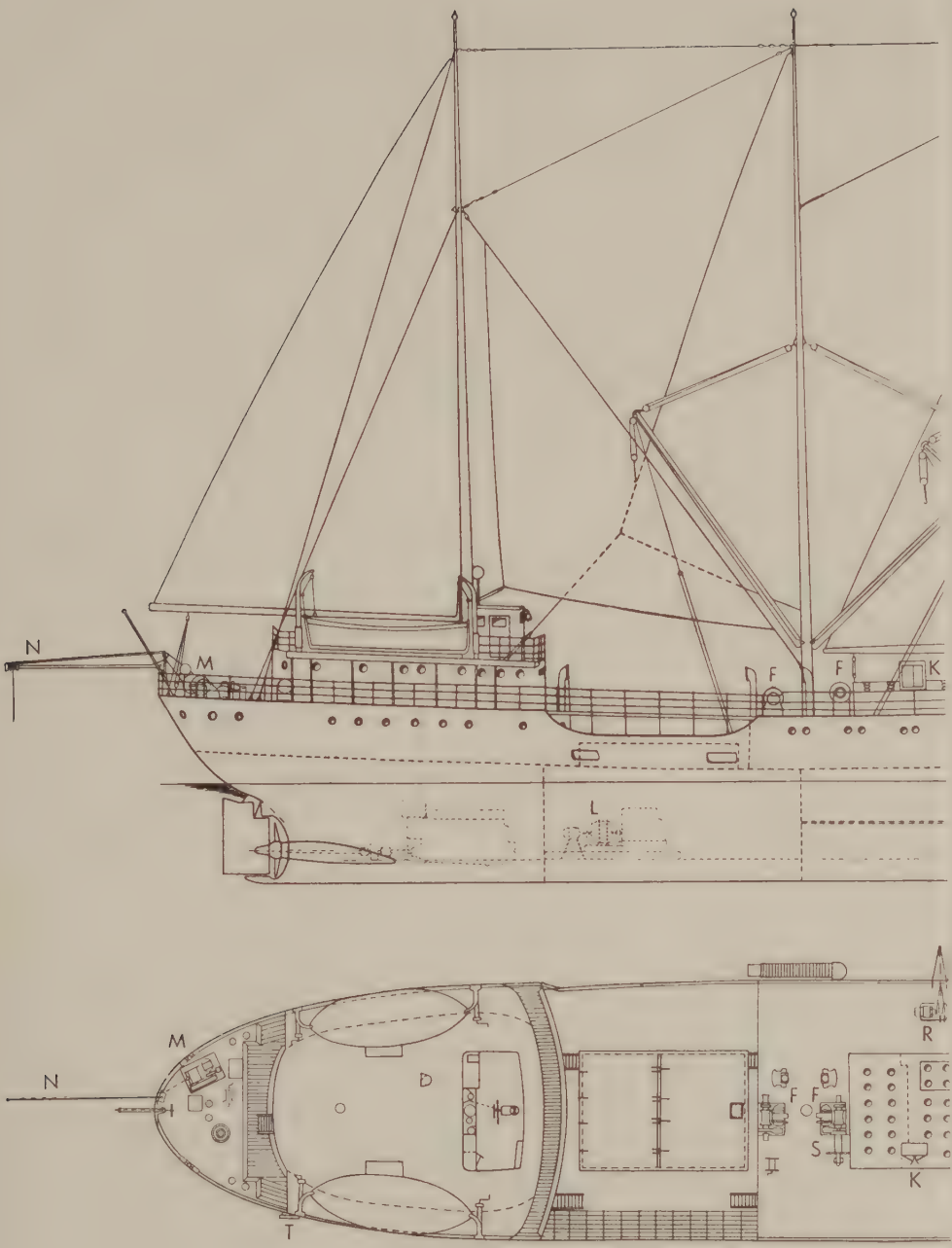
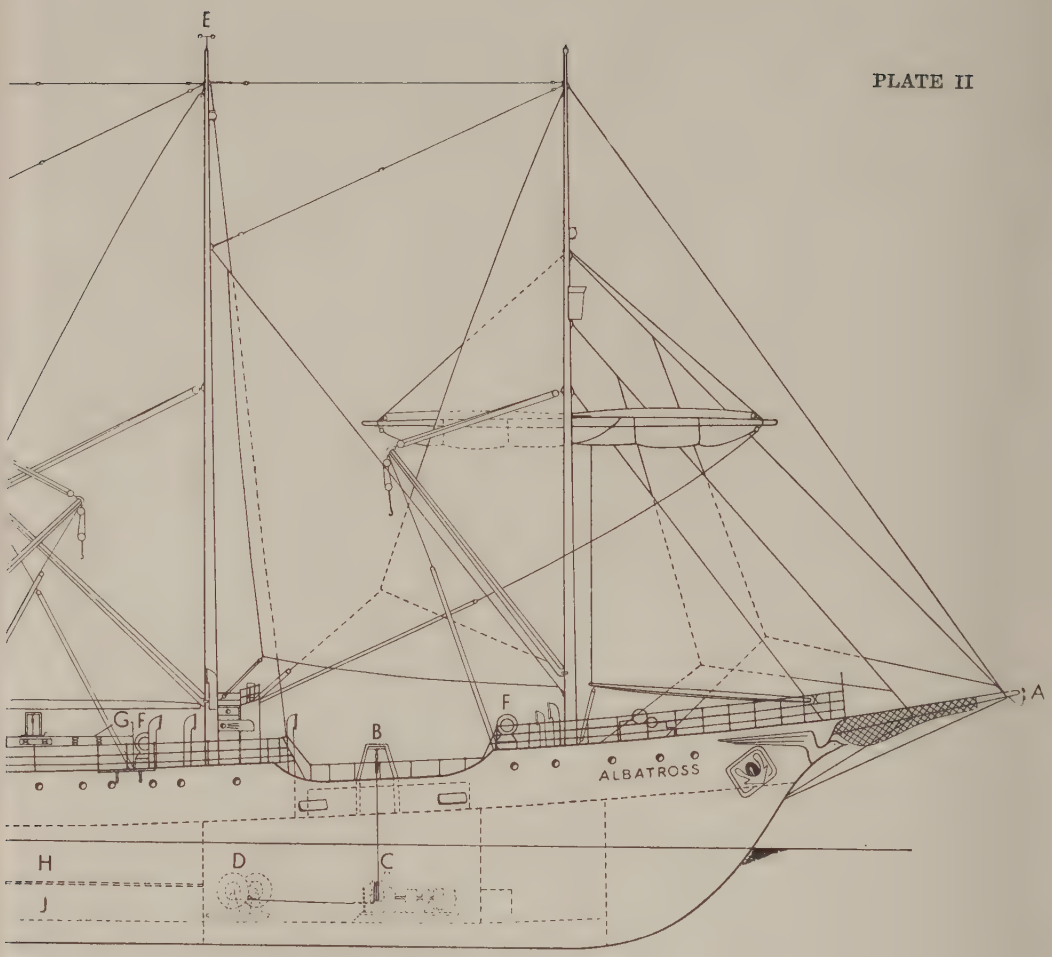
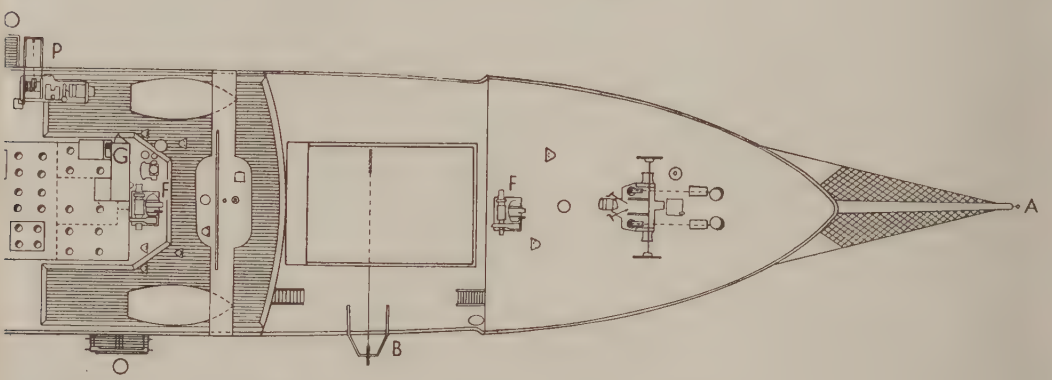


Plate II. A = Deck photometer, B = Davit for piston corer, C = Deep
Barrel for 4,000 m 8 mm cable, G = Entrance lobby, P = Hydrographical w
Diesel engine with dynamo for the deep-sea winch, K = Lift, M = Optical wir
cable





)-sea winch, D = Cable coiling winch, E = Anemometer, F = Deck winches, S = vinch, R = Lucas Sounding machine, H = Laboratories and stores, J = Stores, L = ıch, N = Crane for light measurements, O = Balcony, T = Pully conducting trawling into the sea.

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